1201

ADA234007

ADA239007

RD&E CENTER

Technical Report

No. 13488

TACOM SIMULATION CATALOG

DECEMBER 1989

20020815131

By Ronald R. Beck & Donna A. Croke
U.S. Army Tank-Automotive Command
ATTN: AMSTA-RY
Warren, MI 48397-5000

APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION IS UNLIMITED

U.S. ARMY TANK-AUTOMOTIVE COMMAND
RESEARCH, DEVELOPMENT & ENGINEERING CENTER
Warren, Michigan 48397-5000

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release: Distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 13488	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Tank-Automotive Command 6b. OFFICE SYMBOL (If applicable) AMSTA-RY	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Warren, MI 48397-5000	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
TACOM Simulation Catalog

12. PERSONAL AUTHOR(S)
This catalog was compiled by R. R. Beck and D. Croke

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Catalog	FROM 10/85 TO 2/90	December 1989	136

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Analytical Simulation for Military Vehicles, Physical Laboratory of Vehicles, Subsystems and Components

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report is a catalog of the analytical simulation software packages available at the U.S. Army Tank-Automotive and at its contractors, which allow the modeling and evaluation of different aspects of military vehicle performance. Each model is represented by a short description, input requirement, available output and computer hardware requirements. In addition, current features and limitations are also given. Finally, a point of contact is listed in case the reader needs further information.

Also included in the catalog are the physical simulation facilities or simulators available, in addition to the analytical simulation tools.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Ronald R. Beck	22b. TELEPHONE (Include Area Code) (313)574-6228 22c. OFFICE SYMBOL AMSTA-RY

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

TABLE OF CONTENTS

1.0. INTRODUCTION

The U.S. Army Tank-Automotive Command (TACOM) Research, Development and Engineering (RDE) Center is creating a supercomputer-based analytical and physical simulation system to reduce the time and high cost of conventional military vehicle prototype-based design and development. The RDE Center's simulation capabilities may be divided into two major categories:

- Analytical Simulation
- Physical Simulation

Analytical Simulation is supported by Computer-Aided Design Systems and High-Speed Graphics Workstations located throughout the Center. They are used by TACOM's engineers and scientists for design, modeling, simulation and engineering analysis purposes. The computer-based analytical models are used increasingly for the simulation of most aspects of combat and tactical vehicle performance. Current emphasis is on the simulation and analysis of:

- Cross Country Mobility Performance
- Ride Dynamics
- Truck/Trailer Stability
- Weapon Platform Stability
- Structural Integrity
- System Survivability

TACOM has developed or contributed to the development of several comprehensive models suitable for performing the analytical activities listed above. In addition, commercial packages are also used for finite element analysis.

The RDE Center's Physical Simulation System consists of man and hardware-in-the-loop Motion Base Simulators. A Ride Motion Simulator and a Crew Station/Turret Motion Base Simulator are used to evaluate gunner and driver displays and controls associated with man/machine interaction dynamics issues under simulated ride dynamics conditions. TACOM's full-scale Motion Base Simulators are capable of "shaking" complete combat and tactical vehicle systems weighing up to 40 tons. The purpose of the Physical Simulation Laboratory is threefold:

- To validate analytical models.
- To address man-in-the-loop issues.
- To determine failure points of a vehicle system or subsystem.

Physical Simulations conducted in the laboratory offer accelerated test schedules, repeatable test conditions and, therefore, are often more useful than more expensive, time consuming field tests. These laboratory simulations also allow the engineer to collect data which, otherwise, would be difficult or impossible to obtain.

Simulation has gained wide acceptance in the Army during the past 10-15 years. The U.S. Army Tank-Automotive Command follows a policy which states that simulation will be used in all new vehicle acquisition actions to the maximum extent possible. The Commanding General's Policy Memorandum No. 22-88, 4 October 1988 (see reference, page 9), also states that if it is decided that there is no need to employ simulation in procuring a new vehicle, then the office responsible for this decision must support it with convincing justification.

Why the emphasis on simulation? In general, simulation allows:

- the quantitative evaluation of vehicle performance without building hardware,
- the exploration of many design excursions/ideas,
- the examination of many environmental and operational scenarios (some of which would be dangerous to execute at a proving ground),
- saving considerable time and money in the development and assessment process, and
- TACOM to be a smarter buyer.

The U.S. Army Tank-Automotive Command is well equipped to employ complex simulations. One of the Army's Cray-2 supercomputers is located at TACOM. In addition, the Command's RDE Center has 36 Intergraph Workstations, 2 VAX 8800 computers, a cluster of Prime computers and many smaller but powerful machines, such as an AD100 which controls the Crew Station/Turret Motion Base Simulator.

As the inventory of computer software and hardware grew, the different organizations within the RDE Center developed/purchased/licensed an increasing number of software packages. It soon became clear that a catalog of these was needed so that TACOM managers and engineers would have a means to find out what was available outside their own group. This, of course, will help them to avoid duplications and, perhaps even more importantly, could offer valuable help in the solution of different technical problems.

2.0. PURPOSE

The primary purpose of publishing this catalog of analytical simulation packages and physical simulators available at TACOM is to inform our own managers and engineering staff about what simulation capability is currently available command wide. Therefore, it was decided to distribute this catalog Armywide, with the purpose of offering the use of these tools to other Army agencies in support of their mission. TACOM's point of contact in this regard is Dr. Ronald R. Beck, Chief, System Simulation and Technology Division. (Internal mailing symbol is AMSTA-RY) Telephone: Commerical (313) 574-6228 or AV 786-6228.

3.0. ORGANIZATION OF THE CATALOG

The catalog lists seven sets of simulation tools. These are:

- Annex A - Analytical models/methodologies concerning "Dynamics and Controls"
- Annex B - Cross country "Mobility"
- Annex C - Physical "Simulators"
- Annex D - Models designed to analyze aspects of military vehicle "Survivability"
- Annex E - "Vehicle Subsystem Evaluation Tools"
- Annex F - "Structural Analysis" packages
- Annex G - "Systems and Cost"

Each model and simulator is represented by a short description, input data requirements, available output and hardware requirements. In addition, specific features and limitations are also given. Finally, a point of contact is listed in case the reader needs further information.

DEPARTMENT OF THE ARMY
UNITED STATES ARMY TANK-AUTOMOTIVE COMMAND
WARREN, MICHIGAN 48397-5000

REPLY TO
ATTENTION OF

14 OCT 1988

AMSTA-RY

COMMANDING GENERAL'S POLICY MEMORANDUM NO. 22-88

FOR: SEE DISTRIBUTION

SUBJECT: Use of In-House Analytical and Physical Simulation Capabilities

1. It is my policy that all available pertinent, analytical tools be used to the maximum extent feasible in future acquisition and development actions. For example, the NATO Reference Mobility Model (NRMM), Dynamic Analysis and Design System (DADS), Finite Element Analysis (FEA), Vulnerability Models and other military vehicle performance simulations will be used to evaluate and rank military vehicle systems. The System Simulation and Technology Division (AMSTA-RY) is the principal proponent in the implementation of this policy. Program Executive Officers (PEOs), Weapon System Managers, and others responsible for new acquisitions or Product Improvement Programs (PIPs) will utilize, where feasible, the RDE Center's simulation capabilities for the preparation of good, enforceable technical requirements to be used in the selection of the best competing system.

2. It is necessary that the System Simulation and Technology Division be involved at an early stage of the development/acquisition process. PEOs should plan their programs so that adequate time and funds are allotted for analytical/physical simulations. The System Simulation and Technology Division has developed comprehensive input data requirements which are absolutely necessary for the conduct of realistic analysis. These data must be made part of Request for Proposal documents so that prospective contractors are aware of these requirements at the outset of their involvement with the program. If it is determined that simulation is not necessary for a given acquisition, the rationale supporting this decision will be so documented. The documentation should clearly indicate how all pertinent technical requirements will be established and evaluated.

3. Point of contact (POC) for this effort is Dr. Ronald R. Beck, AMSTA-RY, Ext. 46228.

WS Flynn

WILLIAM S. FLYNN
Major General, USA
Commanding

DISTRIBUTION
AC

ACRONYMS AND ABBREVIATIONS

DYNAMICS AND CONTROLS

ADSIM	Applied Dynamics Simulation
DADS	Dynamic Analysis Design System
MACSYMA	project MAC's SYmbolic MAnipulation system

MOBILITY

NRMM	NATO Reference Mobility Model
OBS78B	Vehicle Obstacle Crossing Prediction Model
VEHDYN	Vehicle Dynamics Model
VRIDE	Vehicle Cross Country Ride Evaluation Package

SIMULATORS

CS/TMBS	Crew Station/Turret Motion Base Simulator
RMBS	Ride Motion Base Simulator
VCDD	VETRONICS Crew Display Demonstrator
VMBS	Vehicle Motion Base Simulators

SURVIVABILITY

ADRPN	Acoustic Detection Range Prediction Model
GRILLESHOT	Design and Evaluation of Armore Grilles
PRISM	Physically Reasonable Infrared Signature Model

VEHICLE SUBSYSTEM EVALUATION TOOLS

C SPICE	Electronic Circuit Analysis
DIESEL CYCLE	Transient Diesel Engine Cycle Analysis
HI-LO	Electronic Circuit Analysis
MISGUIDE	3-D Dynamic Track Simulation
NNEP	Navy-NASA Engine Program
PS**2	Propulsion System Performance Simulation
TRACKDRIVE	Dynamic Track Simulation
TRACKDYNE	Dynamic Track Simulation
TRANSENG	Transient Engine Cycle Analysis

STRUCTURAL ANALYSIS

ABAQUS	General Purpose Linear/Non-Linear FEA (Finite Element Analysis)
ADINA	General Purpose Non-Linear FEA
BRL-CAD	3-D Solid Model CAD Software
BWAP	Battalion Weight Analysis Program
DYCAST	Dynamic Crash Analysis of Structures
NIKE2D	Specialized Non-Linear FEA
NISA	General Purpose Linear FEA (Finite Element Analysis)
PATRAN	Pre and Post Processor for FEA Packages
PINSTRESS	Track Pin Stress Simulation
SUPERSAP	PC Based Finite Element Code
TACO3D	Non-Linear 3D Heat Transfer FEA
TACOME2	Armor Shell Design/Evaluation Tool
TACOME3	Component Level Vulnerability Evaluation
TRACK	Radar Cross Section Simulation System
TTIM	TACOM Thermal Image Model

SYSTEMS AND COST

CASTFOREM	Combined Arms and Support Task Force Evaluation Model
ESS	AMCCOM Environmental Stress Screening Cost Model
FMACM	Fleet Modernization Automated Cost Model
LOGAM	Logfistics Analysis Model
MEL	British Army Maintenance Expenditure Limit Model
MSCM	Multi-System Cost Model
OBCE	Operational Baseline Cost Estimate (OBCE)
OSSAM	Optimum Supply and Maintenance Model
SLEP	Service Life Extension Program Model
TDP	Technical Data Package Cost Trade-Off Analysis Model
VCDM	TACOM Wheeled and Tracked Vehicle Cost Data Base Model
WARCAM	Warranty Cost Analyses Model

ANNEX A

DYNAMICS AND CONTROL

ADSIM (APPLIED DYNAMICS SIMULATION)

DESCRIPTION

ADSIM is a continuous system simulation language expressly designed for the purpose of modeling systems described by time dependent, non-linear differential equations and/or transfer functions. ADSIM is intended to provide a simple method of representing these mathematical models on a digital computer. The ADSIM methodology is best suited for the engineer interested in designing and/or analyzing control system response and stability characteristics. ADSIM is designated for the AD100 computer system. The advantage ADSIM has over other simulation packages is that it can simulate in real time.

INPUT REQUIREMENTS

ADSIM can be implemented by using an equation description of the problem (along with all the appropriate parameters) or a block diagram description. Options exist to examine the system response to a variety of external forcing functions. User-authored macros can also be interfaced with the ADSIM model. The macros can contain standard ADSIM features and FORTRAN statements. Any feature that is needed for a more accurate model can be simulated by the ADSIM library or through the construction of a specialized macro. The current version of ADSIM has matrix and vector math capabilities.

AVAILABLE OUTPUTS

The output from ADSIM will depend entirely on the user requirements for the solution of a particular problem. Whatever variables the user deems necessary for a more complete analysis of the problem at hand can be outputted in either a tabular form or in a graphical representation. In addition the output can be generated in signal form to interface with other devices.

COMPUTER REQUIREMENTS

ADSIM is currently operational on the System Simulation and Technology Division's (AMSTA-RY) Micro/Vax II workstation, node designation ONTARIO which is designated as the host for the AD100 computer system.

CURRENT FEATURES

The ACSL software contains a wide variety of internal macros that can be used to describe a myriad of physical systems (e.g. electrical, mechanical, hydraulic, etc.). Also contained within the ADSIM command library is the ability to alter ADSIM program parameters "on the fly". These include variable step integration flags, memory buffer reallocation flags and efficient CPU usage during computationally intensive portions of a given simulation ADSIM can be used to interface with other data manipulation systems (i.e. CAMAC and AD100 computers) for use in a simulation lab environment.

CURRENT LIMITATIONS

ADSIM has limitations on standard control system analysis techniques such as Bode diagrams. However, TACOM personnel have developed software which supplements with ADSIM to obtain Bode diagrams. ADSIM can also interface with a signal analyzer for additional analysis.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Art Helinski, Warren, Michigan 48397-5000

AC (313) 574-6676 AUTOVON 786-6676

DYNAMIC ANALYSIS AND DESIGN SYSTEM (DADS)

DESCRIPTION

DADS is a general purpose model that simulates the dynamical response of a wide variety of mechanical systems. DADS assumes that a mechanical system can be modeled as a system of discrete bodies interconnected with joints and force elements. DADS can also model control and hydraulic systems. The DADS program is currently being used to model the dynamic response of military tracked and wheeled vehicle systems. It has also been used to derive functions controlling the performance of full scale vehicle simulators. DADS is commercially available through CADSI Inc., Iowa City, Iowa.

INPUT REQUIREMENTS

The following information is required to assemble a DADS simulation model:

The mass, inertia, and initial configuration of each body in the system.

The force vs. deflection and force vs. velocity characteristics of each force element.

Connectivity and dynamic description of each control or hydraulic system to be interfaced with the model.

In the case of a vehicle simulation, tire model parameters, terrain contours and powertrain description.

In the case of a flexible element simulation, mode shapes from a NASTRAN or ANSYS Finite Element Analysis are required.

AVAILABLE OUTPUTS

The DADS programs generates the following output:

The position, velocity and acceleration time histories for each body.

The joint and spring force time histories.

The control state variable and hydraulic system pressure time histories.

Animated graphical output is available with the appropriate post processing software

COMPUTER REQUIREMENTS

DADS can currently be operated on the CRAY-2, VAX, Sun and Silicon Graphics computers.

CURRENT FEATURES

DADS features the following capabilities:

A library of joint, force, control elements.
Capability to model flexible bodies
A simple preprocessor is available for quick data entry.
A tire model is available for full scale vehicle simulation.
User supplied FORTRAN subroutines can be added to enhance program capability.

CURRENT LIMITATIONS

DADS has the following limitations:

Slow execution speed on small computers.
Limited pre and post processing capability.
Limited control and hydraulic modeling capability.
Limited track modeling capabilities in regards to track/soil interfaces.
Compliant/impact dynamics modeling capabilities for hull/turret interactions.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Systems Simulation and Technology Division (AMSTA-RY), Mr. James Overholt, Warren, Michigan 48397-5000

AC (313) 574-8633 AUTOVON 786-8633

MACSYMA

DESCRIPTION

MACSYMA is a large, interactive computer algebra system and programming environment designed to assist engineers, scientists and mathematicians (both theoretical and applied) in solving a wide spectrum of mathematical problems. MACSYMA is commercially available through Symbolics Inc., Cambridge, Massachusetts.

INPUT REQUIREMENTS

MACSYMA is both a programming language and an interactive system. You can communicate with MACSYMA interactively in a purely mathematical language that is almost conversational, while the system automatically maintains a record of all interactions. MACSYMA is easy to work with. In a few minutes, a novice with no computing experience can learn to symbolically solve extremely complicated mathematical problems.

AVAILABLE OUTPUTS

With MACSYMA, the user can perform the following operations (partial list):
Take mathematical limits.
Differentiate expressions.
Compute definite and indefinite integrals symbolically.
Solve ordinary differential equations symbolically.
Factor polynomials.
Simplify expressions.
Expand functions in Taylor or Laurent series.
Solve systems of linear and non-linear equations.
Solve algebraic and polynomial equations.
Manipulate matrices, vectors, and tensors.
Compute LaPlace and inverse LaPlace transforms.
Generate FORTRAN statements from MACSYMA expressions.
Plot curves and surfaces.
Produce numerical results.
Translate programs into LISP for later compilation.

COMPUTER REQUIREMENTS

MACSYMA currently resides on the System Simulation & Technology Division's (AMSTA-RY) Micro/VAX II workstations; node designations ONTARIO and MICHIGAN.

CURRENT FEATURES

The user can modify MACSYMA's understanding and treatment of mathematical problems. The user can control the evaluation and simplification of expressions making MACSYMA a truly intelligent problem-solving environment.

The user can write their own rules or programs and embed this knowledge into the MACSYMA environment.

Many MACSYMA users have contributed programs from their particular applications. Symbolics Inc. distributes these programs in every MACSYMA release.

The user can produce sophisticated plots of expressions with very few lines of MACSYMA code. For example, typing *plot(sin(x),x,-%pi,%pi);* produces a sine wave plot with axes, scaling and the labeling of the maximum and minimum points on each axis.

CURRENT LIMITATIONS

Performance in any computer algebra system varies depending on the size and type of problem you are trying to solve and the computer system that the algebra system is installed on. MACSYMA's performance (in terms of CPU time used) on AMSTA-RY's Micro/Vax II workstation is limited by the current amount of RAM memory that is present in these machines (2 Megabytes). Upgrading the RAM memory to 16 Megabytes is currently being investigated.

With MACSYMA residing on the Micro/Vax II workstations, only two users are allowed at any one time.

Switching between the interactive mode and a graphics mode is not easily doen with the Micro/Vax II workstations. This problem could be made easier by installing MACSYMA on a Sun or Apollo graphics workstation.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RY), Mr. James L. Overholt, Warren, Michigan 48397-5000

AC (313) 574-8633 AV 786-8633

ANNEX B

MOBILITY

NRMM (NATO REFERENCE MOBILITY MODEL)

DESCRIPTION

NRMM is a large scale digital simulation which predicts the on-road and cross-country performance of a vehicle in a global sense. The measure of performance is speed-made-good and percent of an area denied due to immobilizations.

INPUT REQUIREMENTS

Vehicle Geometry
Chassis and Suspension Masses and Inertias
Suspension Characteristics
Power Train Characteristics and Performance
Desired Terrain and Scenario

AVAILABLE OUTPUTS

Tactical Levels of Mobility:
  Speed Profile
  Percent Area Denied
Subsystem Performance:
  Powertrain Performance - Gradeability, Acceleration
  Obstacle Negotiation
  VCI
  Ride Quality

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Wheeled or Tracked Vehicles
Prime Movers or Trailers
(some restriction)
Sensitive to Environment:
  Seasons, Weather, Shallow Snow
Variety of Terrain Scenarios:
  Western Europe, Middle East
  Road Wet, Sand Scenario
Diagnostics
Measured Subsystem Data Replacement
Subsystem Performance
Central Tire Inflation
Large Data Base
Strictly Managed
Vehicle Data Development Program

CURRENT LIMITATIONS

Two Dimensional Simulation
No Wet Linear Features (e.g. rivers)
No Deep Snow
Steady State Powertrain Simulation
No Electric Drive
No Turbine
Only Mechanical/Hydromechanical Transmissions
Trailers Restricted to Two Axles
No Steering
No Sev
Vehicle Dynamics Limited to Small Angle, Pitch Plan Motion

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RY), Mr. Peter Haley, Warren, Michigan 48397-5000

AC (313) 574-8633 AV 786-8633

OBS78B (OBSTACLE CROSSING MODULE)

DESCRIPTION

OBS78B is the obstacle crossing module of NRMM which determines the under-carriage clearance and force history of the vehicle as it traverses a mound or trench type obstacle. It is a stand alone module. The clearances, average and maximum forces to negotiate an obstacle are used as part of the input to the main module of NRMM vehicle data set.

INPUT REQUIREMENTS

Vehicle Geometry
Sprung Mass Location
Suspension Type
Stylized Mounds and Trenches

AVAILABLE OUTPUTS

Clearance, Average and Maximum Forces
Spatial History

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES	CURRENT LIMITATIONS
Wheeled or Tracked Single, Double Axle Trailers Strictly Managed Vehicle Data Development Program	Two Dimensional Limited to: Two Bogied Prime Mover Single Bogie Trailer Statics Model No Track Tension Dry Feature

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Peter Haley, Warren, Michigan 48397-5000

AC (313) 574-8633 AUTOVON 786-8633

VEHDYN (VEHICLE DYNAMICS MODULE)

DESCRIPTION

VEHDYN is a two dimensional pitch plane motion rigid frame vehicle dynamics model which is used to generate the ride quality curves of a vehicle traveling over continuous surface roughness terrain and discrete obstacles. The output is used as part of the input to the main module vehicle data set of NRMM.

INPUT REQUIREMENTS	AVAILABLE OUTPUTS
Vehicle Geometry Chassis and Suspension Masses and Inertias Suspension Characteristics Terrain Profiles Discrete Obstacles	Absorbed Power Vehicle Masses State Variable Histories

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Wheeled or Tracked Vehicles
Prime Movers
Wheel/Tire Enveloping Algorithms
Suspension Component Hysteresis
Standard Suspension Types
Strictly Managed
Vehicle Data Development Program

CURRENT LIMITATIONS

Two Dimensional Simulation
Single Unit Vehicle Systems
Fixed Time Step Integration
No Powertrain Influence
Simplified Track Tension Algorithm

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Peter Haley, Warren, Michigan 48397-5000

AC (313) 574-8633 AUTOVON 786-8633

VRIDE (VEHICLE RIDE QUALITY EVALUATION PACKAGE)

DESCRIPTION

VRIDE is a vehicle dynamics cross-country ride and vibration evaluation and simulation package. Vehicle pre- and post-processors are available for defining the vehicle configuration and tailoring the simulation output to fit the user's specific requirements.

INPUT REQUIREMENTS

Vehicle Geometry
Mass and Inertia Properties
Suspension System Characteristics
Desired Terrain Scenario

AVAILABLE OUTPUTS

Driver limited vehicle speed
Cargo limited vehicle speed
Suspension induced acceleration environment of any vehicle component

COMPUTER REQUIREMENTS

Operational on TACOM's VAX-8800.

CURRENT FEATURES

Includes pitch and yaw
Simple to use pre-processor for data input
Flexible post-processor to investigate vehicle motion time histories
Model is well validated for VRIDE values
Well documented mature model
Nonlinear tire model
Good terrain library exists

CURRENT LIMITATIONS

Does not include vehicle roll
Uses point contact tire model
Does not include track effects

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Chassis & Running Gear Division (AMSTA-RT), Dr. Francis Hoogterp, Warren, Michigan 48397-5000

AC (313) 574-6164 AUTOVON 786-6164

ANNEX C

SIMULATORS

CS/TMBS (CREW STATION/TURRET MOTION BASE SIMULATOR)

DESCRIPTION

The Crew Station/Turret Motion Base Simulator is a six degree of freedom (dof) test device capable of creating chassis disturbance inputs to a fully operational 25 ton turret/gun system simulating a specific operational environment.

INPUT REQUIREMENTS

Desired vibration environment.
Tank mass, inertial, and geometric properties.
High Speed Simulation
Math model describing vehicle/terrain dynamics.
Operational scenario and test plan.
Vehicle CS/TMBS interface characteristics and components.

AVAILABLE OUTPUTS

Gun/turret drive weapon stabilization performance assessments.
Crew station man/machine interaction dynamic displays and control measurements.
Validation/proof-of-principle assessment of subsystems and components.
Implementation and evaluation of modern control strategies.

COMPUTER REQUIREMENTS

Self contained system consisting of Microvax II, AD100 simulation computer, and several microprocessor based controllers and safety monitor computers. Planned to be operational in 1990.

CURRENT FEATURES

Will accomodate up to 25 ton payload.
Manrated system.
Realtime simulation using TMBS and vehicle system feedback.
Handles MANPRINT issues.
Safety systems include active and passive backup.
Self diagnosis of event failures.
Motion performance covers wide range of vehicle/terrain scenarios.
Full six degree of freedom motion base.

CURRENT LIMITATIONS

No Computer Generated Imagery system for crew station.
Operational in FY90.
Software and control algorithms not fully defined for highly active turret systems.
Vehicle CS/TMBS interface issues not completely resolved.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RY), Mr. Harry Zywiol, Warren, Michigan 48397-5000

AC (313) 574-5032 AUTOVON 786-5032

RMBS (RIDE MOTION BASE SIMULATOR)

DESCRIPTION

The Ride Motion Base Simulator is a four degree of freedom test device capable of replicating the shock and vibration environment of a crew station simulating a given operational scenario.

INPUT REQUIREMENTS

Desired vibration environment.
Vehicle mass, inertial, and geometric properties.
Math model describing vehicle/terrain dynamics.
Operational scenario and test plan.

AVAILABLE OUTPUTS

Single occupant crew station effectiveness.
Operator performance under dynamic conditions.
Validation of human vibration and dynamics models.
Crew apparrel effectiveness.
Crew displays and control devices performance assessment.

COMPUTER REQUIREMENTS

Self contained system consisting of Microvax computer integrated in a Computer Automated Measurement and Control system network to the RDE Center supercomputer system.

CURRENT FEATURES

4 degrees of freedom (3 angular and vertical)
Pneumatic and electronic safety backup systems detect anomalous conditions. Uninterruptable power supply.
Reconfigurable environment for controlled studies.
Modular computer control and dat acquisition system allows flexibility of variety of studies.
Computer system networked to RDE Center Supercomputer system.

CURRENT LIMITATIONS

Not man-rated yet.
No computer generated imagery system.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RY), Mr. Alexander Reid, Warren, Michigan 48397-5000

AC (313) 574-6676 AUTOVON 786-6676

VCDD (VETRONICS CREW DISPLAY DEMONSTRATOR)

DESCRIPTION

The VCDD is a crew station simulator capable of assisting in designing/defining crew system interfaces in new or improved ground combat vehicles. The VCDD provides a capability to rapidly reconfigure physical and functional characteristics of an operator station's displays, controls, and interactive dialog features. It consists of a reconfigurable crew-in-the-loop simulation, including vehicle subsystems and tactical environments, and two generic crew stations. The VCDD is a full-mission, fixed-base combat vehicle simulator capable of representing a wide range of operator interfaces. The crew operates the demonstrator vehicle in a simulated environment while conducting a mission against an interactive threat.

INPUT REQUIREMENTS

What type of configuration to use (M1A1, M1A2, HFM, etc)?

A layout of the crew compartment which provides information on the commanders, gunners and/or drivers stations (i.e. size and location of displays and controls) for hardware reconfiguration.

The Crew Interface Design requires the following information:

(1) Displays-layout, description, menu tree and menu functions.
(2) Instruments-layout, description, and functions.
(3) Controls-layout, description, and functions.

Define SMI (Soldier-Machine-Interface) design concept and/or constraints to be evaluated.

The following is required to set up a support mission scenario:

(1) Create a scenario that will be influenced by the design concept.
(2) Place the scenario data into the simulated tactical world.
(3) Make instrument panels that incorporate the design criteria functionally interactive with the mission scneario for evaluation.
(4) Introduce movable targets for gun firing evaluations.

AVAILABLE OUTPUTS

Qualitative evaluation of benefits of implementing the design concept.

Capability to acquire and analyze quantitative performance data.

Ability to quickly change the format of the instrumentation and re-evaluate performance.

Allows for SMI-Crew interaction evaluation.
Hard color copies of the crew displays.

COMPUTER REQUIREMENTS

VCCD system located in VETRONICS Integration Center, TACOM
VAX 11/785
Trillium CGI (Computer Generated Imagery)
IRIS Silicon Graphics
Controller's Station
Noise Generator (Amiga and Perceptionics)
Intercom/Radio System
Two Hardware/Software Reconfigurable Crew Stations
Hard Color Copier

CURRENT FEATURES

VCDD Computer Software for:
- Vehicle Simulation
- Environment Simulation
- Crew Interfaces
- Controller Interfaces

Statistical Analysis System
Sound system and seat vibration sensation (vehicle track, turret slew and gun fire)
User friendly interactive interface for creating and modifying crew displays.
Color printer to obtain hard copies of crew displays and CGI channels.
Capability to simulate Daylight, Forward Looking Infrared (FLIR), and Low Light TV views on two channels of CGI.
Simulated tactical world of Fulda Gap.
Library of instruments (i.e. speedometers, switches, digital readouts, etc).
M1A2 Crew Interfaces (CID, DID, GCDP).

CURRENT LIMITATIONS

Simulator has no motion
Only two crew stations (which can be configured as either commanders, gunners or drivers station)
No force on force
Currently no cupola vision block display (will be incorporated in Oct 1990).
Currently no monocular eyepiece representation for CGI displays (will be incorporated Oct 1990).

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Vetronics Division (AMSTA-RV), Mr. John Brabbs, Warren, Michigan 48397-5000

AC (313) 574-5035 AUTOVON 786-5035

VMBS (VEHICLE MOTION BASE SIMULATORS)

DESCRIPTION

The Vehicle Motion Base Simulator are laboratory devices capable of exciting Army vehicles or systems simulating s specific opering environment.

INPUT REQUIREMENTS

Vehicle or system geometry, mass, and inertia properties.
Operational scenario and test requirements.

AVAILABLE OUTPUTS

Hardware-in-the-loop motion simulation.
Solve terrain induced vehicle hardware structural integrity problems.
Validation of tracked and wheeled vehicle analytical models.
Proof-of-Principle testing of vehicle prototypes at the complete system level.
Suspension test bed studies.

COMPUTER REQUIREMENTS

Self contained system consisting of Microvax computer integrated in a Computer Automated Measurement and Control system network to the RDE Center supercomputing facility.

CURRENT FEATURES

3 degrees of freedom simulation (roll, pitch, and vertical)
Large array of simulated terrains and speeds available.
Driver, powertrain not required for conduct of test.
Faithful simulation of motion dynamics.
Simulators are arranged per vehicle/ system geometry.
Control and digital data acquisition system captures a wide variety of data.
Controlled, repeatable laboratory test conditions.

CURRENT LIMITATIONS

Not man-rated simulators.
Typically long set up time.
Payloads limited to 40 tons.
Some customized fixturing required.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RY), Mr. Harry Zywiol, Warren, Michigan 48397-5000

AC (313) 574-5032 AUTOVON 786-5032

ANNEX D

SURVIVABILITY

ADRPM (ACOUSTIC DETECTION RANGE PREDICTION MODEL)

DESCRIPTION

ADRPM is a computer model that predicts acoustic detection distances of ground combat vehicles whose acoustic signature is known at a reference distance. Basically, it measures the effects of ambient noise, ground cover, terrain and weather on known source levels. Conversely, it can also calculate the signature of the source for a desired distance.

INPUT REQUIREMENTS

Reference Distance
Self Noise of Source
Background Spectrum
Observor Efficiency
Source Height
Detector Height
Weather
Terrain

AVAILABLE OUTPUTS

Target Detection Distance

COMPUTER REQUIREMENTS

ADRPM VII has been implemented on an IBM-A+ compatible machine using MS-DOS. Ity is also operational on UNIX.

CURRENT FEATURES

Low frequency detection limit of 40 Hz for human detectors and 10 Hz for non-human detectors
Range search termination criteria now based on integrated detection
Inhomogeneous atmosphere
Graphic oriented user interface
Detection problem arranged on the screen in the form of block diagrams

CURRENT LIMITATIONS

ISO calculation not based on pure tones
All atmospheric effects are independent
Insufficient data base for the low frequency model change
Room for improvement in the model

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Messrs. Cartwright and Shalis, Warren, Michigan 48397-5000

AC (313) 574-8635/6693 AUTOVON 786-8635/6693

GRILLESHOT

DESCRIPTION

GRILLESHOT is a simulation/evaluation tool designed to analyze small caliber AP and Frag simulator projectile encounters with different armor grille configurations. Various armor grille cross-sectional configurations and materials can be analyzed. GRILLESHOT is designed to operate interactively on the Tektronix 4014 terminal. Graphical display of the grille cross-section, the projectile shotline, and tabular display of the results are provided.

INPUT REQUIREMENTS

Interactively enter:

Grille cross-sectional geometry (from selection table)
Grille materials (from selection table)
Spacing between grille elements
Threat projectile (from selection table) type
Threat projectile velocity
Threat projectile impact point (crossing face of grille)
Threat projectile impact angle
Change in grille description
Change in threat projectile description
Rerun commands interactively

AVAILABLE OUTPUTS

Graphical and Tabular
Determination whether threat projectile penetrates or is stopped by grille
Residual speed of threat projectile
Residual flight path of threat projectile
Residual mass of projectile

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer
Tektronic 4014-1 Terminal

CURRENT FEATURES

New grille cross section coordinates can be created and filed before interactive analysis
Fast, interactive, results
Threat projectile shotlines from all angles of elevation
Graphical and tabular output

CURRENT LIMITATIONS

Two-dimensional analysis
Grille material is limited to steel or aluminum
Certain grille "knee," or folded material conditions create "unable" conditions
Program generally gives "worst case results"

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Mr. Kenneth Lim, Warren, Michigan 48397-5000

AC (313) 574-5389 AUTOVON 786-5389

PRISM (PHYSICALLY REASONABLE INFRARED)

DESCRIPTION

PRISM is a first principles model with some simi-empirical algorithms. The program predicts the surface temperatures of vehicles and soil, road and vegetation backgrounds using measured or modeled meteorological parameters. It is constructed to be a general framework program that can model vehicles in static or dynamic modes of operation, strategic installations such as buildings or fuel storage tanks, and other objects of interest.

INPUT REQUIREMENTS

Faceted vehicle model
Mass and area of facets
Material specific heat, emissivity & absorptivity
Weather data
Operating conditions

AVAILABLE OUTPUTS

Vehicle temperature maps at different times
Time histories of facet temperatures

COMPUTER REQUIREMENTS

VAX 750, VAX 8800, CRAY-2 or IBM AT

CURRENT FEATURES	CURRENT LIMITATIONS
Predicts surface temperature for vehicles, and backgrounds. Can be used for buildings or fuel tanks.	Uses isothermal facets

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Ms. Terry Gonda, Warren, Michigan 48397-5000

AC (313) 574-8911 AUTOVON 786-8911

ANNEX E

VEHICLE SUBSYSTEM EVALUATION TOOLS

C SPICE (ANALOG SIMULATION SOFTWARE)

DESCRIPTION

C Spice is an Analog Simulation software package for both general purpose and system-level simulation of electronic circuits.

INPUT REQUIREMENTS	AVAILABLE OUTPUTS
Electronic Circuit Netlist Voltage Current Frequency	Voltage Current Transient Behavior

COMPUTER REQUIREMENTS

Intergraph CAD System

CURRENT FEATURES

Produce simulations of DC Voltage, AC Frequency Transient Behavior, Analyze of Noise, Distortion and Sensitivity.

CURRENT LIMITATIONS

Available 3rd Quarter 1990

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Design and Manufacturing Technology Directorate, Engineering Design Division (AMSTA-TD), Ms. Jacqueline Walter, Warren, Michigan 48397-5000

AC (313) 574-5876 AV 786-5876

DIESEL CYCLE (ENGINE CYCLE SIMULATION)

DESCRIPTION

Program is a FORTRAN based University of Wisconsin simulation of conditions within the ports, combustion chamber and diesel prechamber (if any) of a diesel or spark ignition single cylinder engine. Pressures, temperatures, mass flow rates, heat transfer rates and equivalence ratios are tracked on a crankangle degree basis through one entire cycle.

INPUT REQUIREMENTS

Extremely detailed geometry and initial conditions for each system (ports, combustion chamber(s))
Heat transfer coefficients, areas, path lengths, thermal conductivities, multipliers, etc.
Valve and piston motion data
Error limits and program control parameters
Heat release data
Data for the TACOM single cylinder engine is the only complete input data set known to exist. It contains some 300 items.

AVAILABLE OUTPUTS

System summaries
Crankangle by crankangle tabulation of variables for each system
Cycle summaries

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer
User tools available

CURRENT FEATURES

Spark ignition, open and prechamber diesel options
Choice of heat release and heat transfer models
Output options include graphics

CURRENT LIMITATIONS

Single cylinder, naturally aspirated
Only one complete set of input data available - not validated for other cases

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Propulsions System Division (AMSTA-RG), Mr. A. C. Lemmo, Warren, Michigan 48397-5000

AC (313) 574-5566 AUTOVON 786-5566

HI-LO (DIGITAL SIMULATION SOFTWARE)

DESCRIPTION

Hi-Lo is a Digital Simulation software package for both general purpose and system-level simulation of electronic circuits.

INPUT REQUIREMENTS

Electronic Circuit Netlist
Voltage
Current
Frequency

AVAILABLE OUTPUTS

Voltage
Current

COMPUTER REQUIREMENTS

Intergraph CAD System

CURRENT FEATURES

Verify logic design. Identify and correct timing problems. Test pattern evaluation and test generation.

CURRENT LIMITATIONS

Available 3rd Quarter 1990

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Design and Manufacturing Technology Directorate, Engineering Design Division (AMSTA-TD), Ms. Jacqueline Walter, Warren, Michigan 48397-5000

AC (313) 574-5876 AV 786-5876

MISGUIDE

DESCRIPTION

MISGUIDE is a large scale digital simulation program which can predict misguiding of track (i.e., track throwing) on a tank due to side-loads such as while ditch crossing while sharp turning on cross-country at speed. The program extends all of the 2-dimensional capacity of TRACKDYNE into three dimensions and allows for the additional simulation of tank roll and yaw, while allowing for the 3-dimensional study of side loads on the track by including the lateral interaction of the track relative to the roadwheels and to the ground surface.

INPUT REQUIREMENTS

All of the input parameters of TRACKDYNE with the addition of:
Track-ground interface via an algorithm whereby the forces and movements resulting from road pad-planar surface interference can be calculated
The shape of the pad's "footprint" can be described by any polygon by no more than ten sets of coordinates locating corners of the polygon
The rubber in the pads is described by a combination of linear and square wave springs and viscous and dry dampers. Spring and damping constants are specified separately for the normal and tangential directions.
Each centerguide is assumed to have two prongs, each prong having two faces. Each centerguide face is modeled as consisting of spherical tip, comnical corner that tapers from the sphere to a point part way down the outer corner of the prong and two lines of possible contact that complete inner and outer boundaries of the face of the prong.
The PINSTRESS program was used as one of the foundation stones of the MISGUIDE program. It was converted from 2-D to 3-D
Unlike TRACKDYNE, MISGUIDE is written to accept curved surfaces, and any reasonable ground contour of unlimited complexity can be specified. The ground contour is specified which may contain collection of mathematical functions or a look-up
Vehicle Control: sprocket rpm on the near side and sprocket torque on the off side

AVAILABLE OUTPUTS

New plotting routines were developed to enable the user to obtain a better understanding of the complex interaction of vehicle and track. The plots include a pictorial view of the vehicle showing the relative positions of the suspension and track parts, a set of curves showing the variation of track related force during one pitch passage cycle, and a set of curves showing the movements of the suspension over a period that may be as long as five pitch passage cycles.
The plotting code was organized as a separate program that utilizes a data file written by MISGUIDE. This allows repeated use of a given data file, as for pictorial views from different directions.
Progress over long runs can be monitored without the recording of excessive quantities of data. When an interesting event is observed, the appropriate part of the run can be repeated with full data output.
A generic ditch profile was devised
A decision can be made to vary tank speed and width of ditch until a combination is found which produce definite misguiding. Various design parameters of track and suspension can be changed to study their effect on MISGUIDE.
MISGUIDE incorporates an energy balance feature similar to that of TRACKDYNE which itemizes energy losses in the system and serves as a check on the correctness of the computations.

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2.

CURRENT FEATURES

Only program in existence that can look at track misguiding and its mechanism.
Diagnostic capability
Plots make process of misguiding easily visable and understandable
Allows for design improvements to prevent misguiding; thus, a tool for designer

CURRENT LIMITATIONS

Does not consider wetness, mud or stones between track and sprocket and track and roadwheels. Ergo, cannot simulate some very important real life conditions leading to track-throwing. At present considers friction drive of track sprocket. The next step in this work should be the integration of the TRACKDRIVE program into MISGUIDE so that the drive sprocket-track interaction is accurately represented.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Chassis & Running Gear Division (AMSTA-RT), Dr. Frank Hoogterp, Warren, Michigan 48397-5000

AC (313) 574-6164 AUTOVON 786-6164

NNEP (NAVY-NASA ENGINE PROGRAM)

DESCRIPTION

NNEP is a general purpose gas turbine cycle simulation program. It is used to predict steady-state performance. Performance is usually in the form of BSFC at given horsepower. Within limits, the user determines the performance parameters of interest.

INPUT REQUIREMENTS

Component Maps (in digital format)
Bleed and Turbine Cooling Paths
Engine Configuration (i.e., mechanical connections)
Controlled Parameters and Schedule (i.e., T7 vs. NPT, T5 vs. HP, etc.)
Design Point Data

AVAILABLE OUTPUTS

Off design component performance (temperatures, pressures, pressure ratios, efficiencies, flows, speeds, etc.)
Engine performance (fuel flow, horsepower, airflow, etc.)

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Steady-state performance only
Handles cycles with heat exchangers, reheat, intercooling or these in any combination
Modular in that almost any turbine cycle and engine configuration can be modelled
Altitude capability
Hot day/cold day capabilities
Off design performance (must have component maps)

CURRENT LIMITATIONS

No transient performance
Complex bleed and turbine cooling is difficult to model
Inventory of component maps is very limited

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Engine Development Branch (AMSTA-RGE), Mr. Eugene Danielson, Warren, Michigan 48397-5000

AC (313) 574-5566 AUTOVON 786-5566

PS**2 (PROPULSION SYSTEM PERFORMANCE SIMULATION)

DESCRIPTION

PS**2 is a tank-automotive evaluation program which utilized the engineering data of the engine, transmission and vehicle to predict system performance characteristics. These characteristics are; 1) slope performance which is presented as speed on grade, 2) full power acceleration which is represented by graphs of speed vs time and distance vs time and 3) fuel consumption which is given as graphs of lines of constant fuel consumption on the sprocket horsepower vs speed plot.

INPUT REQUIREMENTS

Vehicle Specifications:
Engine, Transmission, Gross Vehicle Weight, Active Track Weight, Rolling Resistance, Frontal Area, Air Drag Coefficient

Engine Specifications:
Maximum Horsepower, Installation Loss, Temperature & Altituce Loss, Rated RPM, Idle RPM, Shift Speed, Momnet of Inertia, RPM vs Gross Torque, Accessory Losses, Fuel Consumption Map.

Transmission Specifications:
Gear Shift Time, Moment of Inertia, Gear Ratios, Transfer Case ratio, Final Drive Gear Ratio, Sprocket Pitch Radius, Number of Gears, Normal Starting Gear, Torque Converter Characteristics, Gear Shift Information.

AVAILABLE OUTPUTS

SLOPE PERFORMANCE:
Printout of Tractive Force vs Speed, Plots of Tractive Force vs Speed and Sprocket Horsepower vs speed with Slope Performance Lines

ACCELERATION PERFORMANCE:
Printout of speed and distance at each .1 sec interval. Plots of Speed vs Time and Distance vs Time.

FUEL CONSUMPTION:
Printout of system fuel consumption data. Plot of lines of Constant Fuel Consumption on a plot of Sprocket Horsepower vs Speed for a single transmission operating range.

COMPUTER REQUIREMENTS

PS**2 is currently operational on the PRIME computer. It is written in the SIMSCRIPT II.5 computer language.

CURRENT FEATURES

PS**2 features the following capabilities:

A library of current vehicles, engines and transmissions that are available for quick analysis.

The ability to quickly change the engineering characteristics of the Vehicle, Engine and Transmission to evaluate the effects of these changes on system performance.

CURRENT LIMITATIONS

PS**2 has the following limitations:

The fuel consumption simulation requires 20-30 minutes to make all the calculations required.

There are only three types of transmission possibilities available; Manual, hydro kinetic and hydro mechanical.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Engine Development Branch (AMSTA-RGE), Mr. Eugene Danielson, Warren, Michigan 48397-5000

AC (313) 574-5566 AUTOVON 786-5566

TRACKDRIVE

DESCRIPTION

TRACKDRIVE is a three-dimensional dynamic simulation of a portion of a track loop including track on the sprocket and in approaching and leaving spans. The purpose of the program is to investigate the efficiency and smoothness of operation of the sprocket teeth as they engage the track, to evaluate stresses in the track structure as it passes over the sprocket, and to determine the circumstances that will lead to a tooth skipping event. Dry friction contact between the complex shapes of sprocket teeth and end connectors is modeled in detail, and this function comprises much of the TRACKDRIVE program.

INPUT REQUIREMENTS

Number of pitch passage cycles to be run in this simulation
Hardware specification indicator
Initial condition source indicator
Calcomp plot indicator
Speed of track relative to hull
Torque applied to sprocket
Total tension to be maintained in track
Coefficient of dry friction between sprocket teeth and end connectors
Sprocket tooth geometry specification and moments of elasticity
Bushing end distances to plane of sprocket
Radial spring rate of bushing rubber
Viscous damping for bushing rubber
Number of track links in system

AVAILABLE OUTPUTS

Average velocity at the outgoing end of the track where tension is controlled
Horsepower transmitted to sprocket by final drive
Data (geometric) on track passage over sprocket
Data (moment, and total forces) transmitted to the sprocket by the track
Link parameters such as angular deflection of shoes, position and angular orientation of centerguide
Contact parameters of teeth with sprocket, such as location of normal to surfaces, and forces on end connectors
Energy balances
Pictorial diagrams
Plots of tension, pin stress, bending stress and bending moment in the structural bridge between shoes of Diehl-type track as they pass from entrance of the system to the exit
Contact force plot
Hull force and sprocket torque plots
Final conditions
Diagnostic Outputs

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2.

CURRENT FEATURES

Enables full study of track/sprocket behavior three-dimensionally:
The only such program in existence

CURRENT LIMITATIONS

None, provided good data on pin, connector, shoe steel and rubber properties are given

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Chassis & Running Gear Division (AMSTA-RT), Dr. Francis Hoogterp, Warren, Michigan 48397-5000

AC (313) 574-6164 AUTOVON 786-6164

TRACKDYNE

DESCRIPTION

TRACKDYNE is a two-dimensional dynamic simulation program of an entire track loop, including vehicle suspension, hull dynamics, and interaction of the track with a road surface. Only one side of the vehicle is simulated. When calculating hull motions, it is assumed that both sides are undergoing the same events. The action of the sprocket is simplified by treating it as a traction drive into the rubber of the track rather than as a toothed drive into the end connectors.

INPUT REQUIREMENTS

Shock absorber specification
Support roll specification
Chassis and suspension masses and inertias
Vehicle mph; and rate of change
Drawbar pull; and rate of change
Walk coefficient
Geometry of vehicle and track, links, shoes, pins
Tractive effort
Road gradient and terrain specification
Setting of adjusting link in compensating linkage
Static preload tension in track
Suspension characteristics and attitude
Rubber deformation
Number of cycles for which full data are to be printed, and energy balance is to be performed

AVAILABLE OUTPUTS

Program estimates final drive rpm
Final drive torque required
Data may be printed for all cycles
Each cycle is summarized by a single line
Calcomp plots: pictorial representation of track, suspension and road
Area of the footprint is printed
Average HP in and out
Station data which are pitch passage cycles
Hull parameters: horizontal and vertical position, an acceleration and velocity of c.g. in world coordinate system. Pitch angular acceleration, angle and pitching angular velocity of hull
Shoe parameters
Tension in track
Wheel parameters: sprocket, support rolls, idler, and road wheels, around circuit

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2.

CURRENT FEATURES

Time "frozen" plots of track enabling study of standing waves
Numerical data on HP losses in bushings, pads, sliding contact, road friction, roadwheels and idler
Energy dissipated by dampers
Well documented.

CURRENT LIMITATIONS

Two dimensional simulation; ergo, two sides "see" implicitly the same
Sprocket simulated as a friction drive rather than toothed drive
No roll or yaw

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Chassis & Running Gear Division (AMSTA-RT), Dr. Francis Hoogterp, Warren, Michigan 48397-5000

AC (313) 574-6164 AUTOVON 786-6164

TRANSENG (TRANSIENT ENGINE CYCLE SIMULATION)

DESCRIPTION

TRANSENG is a detailed thermodynamic simulation of multicylinder diesel engines. TRANSENG can simulate both naturally aspirated and turbocharged, four stroke diesel engines under transient and steady-state conditions. Program output includes global engine performance parameters such as power, efficiency, and fuel consumption, as well as detailed internal conditions such as pressures, temperatures, and heat-transfer thru surfaces.

INPUT REQUIREMENTS

General Engine Specifications:
Number of Cylinders, Bore, Stroke, Firing Order, etc.
Detailed Engine Specifications:
Effective Valve Flow area vs. Crank-angle, Detailed Combustion Chamber Geometry (including wall thick nesses for heat transfer), etc.
Turbomachinery Maps:
Detailed turbine and compressor maps including Swallowing Capacity, Pressure Ratio, and Efficiency vs. Corrected Rotor speed
Transient Response Data:
Engine Inertia, Fuel Pump Map, Governor Performance Parameters
Initial Conditions:
Good estimates of initial conditions including Temperature, Pressure and Equivalence Ratio in each control volume, Rotor Speed of turbocharger, etc.

AVAILABLE OUTPUTS

GLOBAL PERFORMANCE:
Brake and Indicated;
- Power
- Fuel Consumption
- Air Consumption

Engine Volumetric Efficiency
Turbomachinery Operating Point:
- Rotor Speed
- Pressure Ratio
- Efficiency

Governor Response (Transient only):
- Fuel Rack Position
- Amount of Fuel Injected
- Engine Speed

INTERNAL CONDITIONS:
Control Volume:
- Pressure
- Temperature
- Equivalence Ratio
- Heat Transfer
- Mass Flow

Combustion Chamber Surface:
- Temperature
- Heat Transfer Coefficient
- Heat Flux

Combustion Parameters:
- Ignition Delay
- Combustion Duration
- Heat-release Model Coefficients

COMPUTER REQUIREMENTS

TRANSENG is currently operational on the PRIME computer.

CURRENT FEATURES

Up to 16 Cylinders
Single or Two stage turbocharging
Simplified turbocharging with pressurized intake and exhaust flow nozzle
Transient response to both load and governor setting changes
Automatic generation of 62 node solid heat transfer network based on combustion chamber geometry and material, with optional ceramic insulating coatings

CURRENT LIMITATIONS

Turbo Compounding and Mechanical Supercharging not available
Cannot simulate Indirect Injection (pre-chamber combustion) Diesels
No stress analysis (not a mechanical design tool)
Only one combustion model (representing current practice)

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Propulsions System Division (AMSTA-RGRD), Mr. Matthew McGough, Warren, Michigan 48397-5000

AC (313) 574-6147 AUTOVON 786-6147

ANNEX F

STRUCTURAL ANALYSIS

ABAQUS

DESCRIPTION

ABAQUS is a general purpose finite element program designed to be used for engineering analysis.

INPUT REQUIREMENTS

Component Geometry
Material Properties
Loadings
Constraints
Temperature
Element Type
Procedures
User Defined Input

AVAILABLE OUTPUTS

Displacements
Stresses
Strains
Temperature Distribution
Eigenvalues
Mode Shapes
User Defined
Output

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2 Supercomputer.

CURRENT FEATURES

Ease of use.
Complete consulting
Hotline services
Element Types:
All standard elements for Linear, Static, Dynamic and heat transfer.
Specialized Elements For:
- Contact problems
- User Defined Elements
- Super Elements and Substructuring

Materials Available:
- Special Linear and Nonlinear
- Plastic Models
- Rate Dependent Creep Model
- Accoustic Models
- Visoelastic and Hyperelastic Models
- User Defined Material Laws

Procedures Available:
- Standard Static and Dynamic Analy sis
- Buckling
- Heat Transfer
- Random Response

Many User Defined Capabilities

CURRENT LIMITATIONS

Needs a preprocessor
No fluid Analysis

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation & Technology Division (AMSTA-RYC), Mr. Milton Chaika, Warren, Michigan 48397-5000

AC (313) 574-5363 AV 786-5363

ADINA (AUTOMATIC DYNAMIC INCREMENTAL NONLINEAR ANALYSIS)

DESCRIPTION

ADINA is a general purpose, non-linear finite element program for routine and advancedengineering analysis. ADINA permits command language input, data generation and extensive error checking.

INPUT REQUIREMENTS

Component geometry
Material properties
Loadings
Element types
Constraints
Temperature

AVAILABLE OUTPUTS

Reaction loads
Stresses
Deflections
Eigenvalues
Mode shapes
Temperature gradient

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2 Computer.

CURRENT FEATURES

Analysis capabilities:
- Routine or complex static analysis
- Frequency
- Vibration and wave propagation
- Implicit time integration
- Time history
- Mode superposition
- Automatic load stepping
- Substructuring
- Heat transfer
- Coupled fLuid structure
- Soil structure

Element types:
- Truss
- Beam
- Solid
- Axisymmetric
- Plate
- Shell
- Pipe
- Plane stress and strain

Large material model library for civil, mechanical, nuclear, ocean, and aeronautical engineering problems

CURRENT LIMITATIONS

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Ken Ciarelli, Warren, Michigan 48397-5000

AC (313) 574-5363 AUTOVON 786-5363

BRL-CAD MGED (MULTI-DEVICE GRAPHICS EDITOR)

DESCRIPTION

INPUT REQUIREMENTS	AVAILABLE OUTPUTS
3-D description of vehicle, defined by "primitives"	Solid model of vehicle and components (in the proper format for vulnerability analysis)

COMPUTER REQUIREMENTS

Machine with UNIX Operating System and a "C" Compiler

CURRENT FEATURES

Can create your own parts library
Materials data base

CURRENT LIMITATIONS

Entire vehicle must be defined using primitives

POINT OF CONTACT

At TACOM: Ms. Cheryl Robinson, (AMSTA-ZEA) AC 313-574-5464, AV 786-5464
Ballistics Research Laboratory, ATTN: SLCBR-VL-V, Mr. Keith Applin, Aberdeen Proving Ground, MD 21005-5066
AC (301) 278-6647 AV 298-6647

BATTALION WEIGHT ANALYSIS PROGRAM (BWAP)

DESCRIPTION

The BWAP is a computer program that models an armored battalion based on weight and cube. The BWAP will perform "what if" analyses which will determine how an armored battalion's weight and cube is effected by modifying the structure of the Major Equipment Items (MEI), personnel requirements, logistical doctrine, scenario duration, force structure.

INPUT REQUIREMENTS

Terrain type
Daily displacement (miles/km)
Length of excursion
Battalion type
Conflict mode
MEI modifications

AVAILABLE OUTPUTS

Weight and cube (volume) of MEI's

COMPUTER REQUIREMENTS

IBM (compatible) personal computer

CURRENT FEATURES	CURRENT LIMITATIONS
Terrain types: cross country, highway Daily displacement Length of excursion Selection of battalion type Conflict mode: attack or defend MEI; tracked, trailer, truck, equipment, fuel parameters	Generalized MEI breakdown No RAM data

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Advanced Systems, Concepts and Planning Directorate, Advanced Systems Concepts Division (AMSTA-ZEA), Mr. Mark Kossak, Warren, Michigan 48397-5000

AC (313) 574-8597 AV 786-8597

DYCAST/GC

DESCRIPTION

DYCAST/GC is a dynamic large structural deformation model developed for analyzing the collapse of automotive structures which occur during a crash. This model is based on beam theory of structural mechanics and is a distributed mass model.

INPUT REQUIREMENTS

Control parameters
Element connectivity
Nodal coordinates
Nodal constraints
Initial displacements and velocities
Lumped (non-structural) inertia
Material properties
Element cross-sections
Nonlinear spring properties
Applied dynamic loads

AVAILABLE OUTPUTS

Print-out:
 Nodal displacements, velocities, accelerations
 Element stresses, strains, forces, moments
 Element plasticity distribution
 Element failure
 Energy content by type
Output file (tape, disk):
 Displacement, velocity, acceleration at each time step
 Strain, stress, forces, moments, etc. at specified steps for restart

COMPUTER REQUIREMENTS

IBM, CDC, CRAY, CYBER 205

CURRENT FEATURES

CAD-like pre-processor
Graphics post-processor
Multiple solution procedures
Nonlinear deformation modeling
Elastic/plastic, isotropic, and orthotropic materials
Extensive model element library
Lumped or consistent masses
Applied loads, displacements, and accelerations

CURRENT LIMITATIONS

No mesh refinement
Limited shell elements
No interrupt restart

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Peter Haley, Warren, Michigan 48397-5000

AC (313) 574-8633 AUTOVON 786-8633

NIKE2D

DESCRIPTION

NIKE2D is a vectorized, implicit, finite-deformation, large strain, non-linear finite element code for analyzing the response of 2D axisymmetric and plane strain solids. NIKE3D is a vectorized, fully implicit, 3D, finite element program for analyzing the finite-strain, static and dynamic response of inelastic solids, shells and beams.

INPUT REQUIREMENTS	AVAILABLE OUTPUTS
Component geometry	Reaction loads
Material properties	Stresses
Loadings	Deflections
Element types	Eigenvalues
Constraints	Mode shapes
Temperature	Temperature gradient

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES	CURRENT LIMITATIONS
NIKE2D: Traction boundary conditions Concentrated nodal load points Body force loads due to accelerations and spinning Elastic, orthotropic, elastic-plastic, soil and crushable foam, thermo-elastic-plastic, and linear viscoelastic material models are used.	

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Ken Ciarelli, Warren, Michigan 48397-5000

AC (313) 574-5363 AUTOVON 786-5363

NISA

DESCRIPTION

NISA is a general purpose linear finite element program with a full set of features required to analyze real engineering problems. It also has an extensive library of elements, including laminated composites, and a very efficient wavefront solution and optimization technique.

INPUT REQUIREMENTS	AVAILABLE OUTPUTS
Component geometry	Reaction loads
Material properties	Stresses
Loadings	Deflections
Element types	Eigenvalues
Constraints	Mode shapes
Temperature	Temperature gradient

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer
Slated for usage on TACOM's CRAY-2

CURRENT FEATURES

Analysis capabilities:
- Linear and nonlinear static
- Harmonic
- Normal mode and eigenvalue transient dynamic
- Shock spectrum
- Frequency response and random vibration
- Steady state and transient heat transfer

Element types:
- Isoparametric linear
- Parbolic
- Cubic
- Linear parabolic
- General shell
- Laminated composite
- Thick shells
- Solids
- Beams
- Spars
- Springs
- Mass
- Gap
- Rigid

CURRENT LIMITATIONS

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Milton Chaika, Warren, Michigan 48397-5000

AC (313) 574-5363 AUTOVON 786-5363

PATRAN

DESCRIPTION

PATRAN is an open-ended, general-purpose, 3D, integrated Computer Aided Engineering pre- and post-processor that links engineering design, analysis, and results evaluation functions.

INPUT REQUIREMENTS

Component geometry
Material properties
Loadings
Element types
Constraints
Temperature

AVAILABLE OUTPUTS

Stresses
Reaction loads
Deflections
Temperature gradient
X-Y bar chart plotting
Contour plots
Deformation plots
Video animation of transient results
Light source shading

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer and VAX Computer.

CURRENT FEATURES

Geometry construction, viewing and editing
Finite element modeling (node and element generation)
Graphic display of analysis results
Hidden line removal
Interfaces with many analysis codes
Color graphics
Linear static and dynamic analysis
Interfaces with NISA, ADINA and PATRAN FEA packages

CURRENT LIMITATIONS

Analysis package option not included in TACOM's copy

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Roberto Garcia, Warren, Michigan 48397-5000

AC (313) 574-5363 AUTOVON 786-5363

PINSTRESS

DESCRIPTION

Up to the recent time of MISGUIDE development, PINSTRESS was a 2D program which had been developed to relate external loads on a track to its deflections and internal stress. It has now been made into a 3D model. The PINSTRESS model enables deflections, rotations and stresses to be calculated when an arbitrary pattern of forces and movement is given or alternately, forces, moments and stresses may be calculated when deflections and rotations are known. PINSTRESS I was a computerized analysis of a single-pin span modeled in a relatively simple way. It served to demonstrate that pin distortions are important to the performance of double-pin track. To improve the accuracy of the calculations, PINSTRESS II was developed with a more complex model. It still comprehended only one pin span, and was not computerized. In PINSTRESS III, the analysis was refined a bit further, and four of the PINSTRESS II models were combined to provide a simulataneous solution for the four interrelated spans comprising the connector assembly of a double-pin, double-row track link. PINSTRESS III was computerized because the computations had become almost prohibitively time-consuming to do by hand. PINSTRESS IV was developed at the same time to perform a similar function for double-pin, single-row track much as the T-150, which has only two pin spans per connector assembly.

INPUT REQUIREMENTS

Geometry of pin, bushing and connectors, shoe body, sprocket teeth
Masses of above
Elastic properties of above
Forces and moments applied to the track shoes and end connectors

AVAILABLE OUTPUTS

Displacements and rotations of pins, track shoes, and end connectors
Plots of bending moments that are developed along the four pins
Shearing forces and bending stress at pin-connector junctions
PINSTRESS Output also provides printer listings of numerous deflections and forces together with transfer functions relating inputs and outputs for given geometries and materials

COMPUTER REQUIREMENTS

Operational on TACOM's CRAY-2.

CURRENT FEATURES

In-planes tangential stresses on pin
Out-of-plan perpendicular stress on
Incorporation of PINSTRESS into
MISGUIDE
Excellent for checking strains
(ergo, stresses measured by
strain gages in the field)

CURRENT LIMITATIONS

None

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Chassis & Running Gear Division (AMSTA-RT), Dr. Francis Hoogterp, Warren, Michigan 48397-5000

AC (313) 574-6164 AUTOVON 786-6164

SUPERSAP

DESCRIPTION

Finite Element Program for 2D and 3D Mechanical and Structural Stress as well as dynamic analysis.

INPUT REQUIREMENTS

Part Geometry
Density
Loadings
Part Boundary Conditions

AVAILABLE OUTPUTS

Principal Stresses
Von Mises Stress
Displacements
Shear Stress
Bending Moments

COMPUTER REQUIREMENTS

Run on IBM AT compatible w/min 640K RAM, 20MB Hard Disk, and Math Coprocessor

CURRENT FEATURES

Pre and Post Processing
Modular included
Will accept all PC CAD Models
Static and Dynamic Analysis
Beam Analysis

CURRENT LIMITATIONS

Max Model Size 2000 degrees of freedom (dof)
Just Wireframe Modeling
No Nonlinear Analysis
No Automesh Generation

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Design and Manufacturing Technology Directorate, Engineering Design Division (AMSTA-TD), Mr. Kyle Nebel, Warren, Michigan 48397-5000

AC (313) 574-5525 AV 786-5525

TACO3D

DESCRIPTION

TACO3D is a 3D, finite element program for heat transfer analysis. It can perform linear and nonlinear analyses and can be used to solve either transient or steady-state problems.

INPUT REQUIREMENTS

Component geometry
Material properties
Element types
Constraints
Temperature
Loadings (thermal)

AVAILABLE OUTPUTS

Temperature gradient
Heat values
Temperatures at the nodes
Time histories of temperatures

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Isotropic and orthotropic materials
Time or temperature dependent material properties
Time and temperature dependent boundary conditions and loadings
Radiation boundary conditions
Internal heat generation
Enclosure radiation
Bulk nodes
Free-field input format
Master/slave internal surface conditions

CURRENT LIMITATIONS

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, System Simulation and Technology Division (AMSTA-RY), Mr. Roberto Garcia, Warren, Michigan 48397-5000

AC (313) 574-5363 AUTOVON 786-5363

TACOME2

DESCRIPTION

TACOME2 is a design/evaluation tool for analysis of different armor shell configurations. Using three or four sided plate descriptions, a vehicle's armor configuration can be modeled and analyzed. In the design mode, the model will recommend the plate thickness required, given the configuration description, armor plate material to be used, level of protection desired, and threat description. In the evaluation mode, the model will determine the level of protection available given the armor thickness, material, system configuration and threat description.

INPUT REQUIREMENTS

Armor configuration description, three dimensional coordinate inputs
Threat selection, threat range, az and elevation
Armor plate material selection
Armor plate thickness, if in evaluation mode
Protection level desired, if in design mode

AVAILABLE OUTPUTS

In evaluation mode the probability of penetration of the armor configuration
In design mode the recommended armor plate thickness, for each plate, required to meet the desired level of protection
All results are in tabular form

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Given armor shell configuration, TACOME2 will give quick presented area weighted design or evaluation results
Design or evaluation with selection of small or large AP projectiles
Provide armor plate thickness designs to the desired level of protection
Different armor plate materials can be used during each analysis

CURRENT LIMITATIONS

Limited to 500 armor plates
Cannot simulate multi-layered or spaced armor plate designs
Limited to metallic armor materials
Operating on the Prime Computer System, cannot run classified problems
Database of threat and target material getting outdated, due to lack of funds for improvements

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Mr. Kenneth Lim, Warren, Michigan 48397-5000

AC (313) 574- 5389 AUTOVON 786-5389

TACOME3

DESCRIPTION

TACOME3 is a component level vehicle vulnerability evaluation model. It uses the same armor shell configuration description as TACOME2 plus additional descriptions of major internal and exterior components. TACOME3 will provide probability of kill information give KE or CE threat description.

INPUT REQUIREMENTS

Armor configuration description, three dimensional coordinate inputs
Component configuration descriptions, three dimensional coordinated inputs
KE threat selection, range, az and elevation
CE threat description, az and elevation
Armor plate material selections
Armor plate thickness
Component probability of kill information

AVAILABLE OUTPUTS

Probability of kill information of vehicle; K-kill, M-kill, FP-kill, etc.
All results are in tabular form

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer

CURRENT FEATURES

Given armor shell configuration and vehicle component descriptions, TACOME3 provides reasonably quick probability of kill estimates. Unique about TACOME3 is that input descriptions are much simplier than other vulnerabiity models. It uses the same armor plate descriptions as used in TACOME2. Major components are also described with an outer shell plate description approach. Allows analysis with various KE and CE threats at selected angles of approach.

CURRENT LIMITATIONS

Limited to single layered armor shell plate descriptions. Limited to 500 armor plates, 13 internal and 13 external components. Limited to use of metallic armor plate materials. Database on component kill tables and of threat and target material cannot run classified problems

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Mr. Kenneth Lim, Warren, Michigan 48397-5000

AC (313) 574-5389 AUTOVON 786-5389

TRACK

DESCRIPTION

TRACK is a radar signature analysis model used for analyzing the radar cross section (RCS) of complex targets. Targets are modeled as a collection of simple geometric shapes for which the RCS can be calculated. TRACK calculates the RCS based on specified radar, target, and terrain input parameters.

INPUT REQUIREMENTS

Vehicle geometry
Electromagnetic Scattering properties of target:
- Surface scattering properties
- Surface correlation
- Material type
  - Metallic, dielectric, radar absorbing material

Description of Radar System employed by the seeker (i.e., frequency, polarization, antenna beam width)
Range

AVAILABLE OUTPUTS

Total RCS of target
Statistical distributions of RCS values
Range profiles
Major scattering centers

COMPUTER REQUIREMENTS

Operational on a UNIX system V [2] or VAX ULTRIX or VMS 4.6 (or higher)

CURRENT FEATURES

Concept or existing vehicles
Wide frequency range (.1 GHz - 100 GHz)
Linear or circular polarizations on transmit and receive
Coherent or incoherent RCS measurements
Approximates curved earth, multipath from ground plane, and near field effects
Target moves independent of radar in yaw, pitch and roll

CURRENT LIMITATIONS

Grass terrain only

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Ms. Isabelle Lozon, Warren, Michigan 48397-5000

AC (313) 574-6693 AUTOVON 786-6693

TTIM (TACOM THERMAL IMAGE MODEL)

DESCRIPTION

TTIM has been developed to provide a tool to investigate vehicle survivability by displaying a simulated image of a vehicle as it would appear to an operator of a thermal imaging system under varying conditions. TTIM does not predict the thermal properties of a vehicle or it's background, but instead uses an actual (or modeled) complex thermal image scene radiance (or apparent temperature) map as an input and maps the atmospheric effects, battlefield effects, and sensor effects into the image pixel by pixel.

The model is menu driven and is very flexible. The parameters used in describing the atmospheric conditions, the sensor, and the smoke/obscurants can be changed easily to simulate any battlefield conditions. There are libraries in which the senTTIM (TACOM THERMAL IMAGE MODELsor and obscurant descriptions can be maintained for easy recall. TTIM is based on several different models which have become standards in the industry. The main ones being LOWTRAN6 for the atmospheric effects, ACTMAD for the battlefield smoke/obscurants, and for the sensor effects a module which is heavily structured around the Static Performance Model.

INPUT REQUIREMENTS

Measured or synthetic calibrated scene radiance or apparent temperature maps
Natural atmospheric effects as used by LOWTRAN6
Sensor parameters for various systems
Battlefield obscurant effects parameters describing munitions/geometry

AVAILABLE OUTPUTS

TTIM outputs an image which simulates the display of an infrared sensor based on atmospheric, battlefield, and sensor effects.

COMPUTER REQUIREMENTS

Code is written in ANSI Standard FORTRAN77.

CURRENT FEATURES

Accepts either calibrated radiance or apparent temperature map as input
Real time animations can be developed (using single frames)
Incorporates natural atmospheric effects (LOWTRAN6)
Simulates smoke/obscurants effects
Sensor and smoke/obscurant parameters can be saved in easily recalled libraries
3-D atmospheric effects
User friendly (menu driven)

CURRENT LIMITATIONS

Very CPU intensive, especially smoke/obscurant modeling
Initial input of new characteristics are lengthy

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Tank-Automotive Technology Directorate, Survivability Division (AMSTA-RS), Mr. Gary Martin, Warren, Michigan 48397-5000

AC (313) 574-8911 AUTOVON 786-8911

ANNEX G

SYSTEMS AND COST

COMBINED ARMS AND SUPPORT TASK FORCE EVALUATION MODEL (CASTFOREM)

DESCRIPTION

CASTFOREM is a high resolution, two sided, force on force, stochastic systematic model of combined arms conflict.

INPUT REQUIREMENTS

Battlefield terrain.
Force sizes and structures.
Inventory of:
- Weapons
- Sensors
- Communication devices, etc.

Tactics.
Initial force locations.
Road network.
Battle positions.
Tactical areas.
Decision tables.

AVAILABLE OUTPUTS

Model yields:
- History files of unit actions
- Decision table audits

For Processor Yields:
- Ammo expenditures
- Aspect angle
- Artillery accuracy
- Artillery queuing
- Coincidence statistics
- Commander kills
- Direct energy negations
- Engineer events
- Firers
- Impacts
- Integrity of unit positions
- Kills/range
- Laser damage
- MCP moves
- M/F/C kills
- Moves
- Net usage
- Plots on losses
- Recorded detections
- Rounds
- Search times
- Smoke
- Targets
- Unit summary

Graphical Playback of Battle

COMPUTER REQUIREMENTS

Developed and runs on a VAX with a SIMSCRIPT II.5 compiler. Graphics option requires a RAMTEK display terminal and interface.

CURRENT FEATURES

Direct fire ground weapon systems.
Helicopters.
Dismounted infantry.
Artillery.
Engineering operations
CSS functions.
Communications.
Maneuver with route selection.
Detailed search and acquisition.
Realistic battlefield.

CURRENT LIMITATIONS

Limited TACAIR.
Limited NBC warfare.
No EW.
No vehicular battlefield dust.

POINT OF CONTACT

At TACOM: Mr. David Grant, AMSTA-VS, AC (313)574-8698 AV 786-8698
U.S. Army TRADOC Analysis Command-WSMR Simulation and Computer Support Directorate, ATRC-WEB (Mr. Carroll Denney), White Sands Missile Range, NW 88002-5502
AC (505) 678-1881 AUTOVON 258-1881

AMCCOM ENVIRONMENTAL STRESS SCREENING COST MODEL-MODULE 1

DESCRIPTION

The AMCCOM Environmental Stress Screening Cost Model is composed of three modules, each of which model an aspect of the envorinmental stress screening problem.

Module 1 of AMCCOM Environmental Stress Screening Cost Model is Optimize Stress Screening. This module establishes a base-line stress screen which is used to develop the final screen using AMC-R-702-25. The final screen selection must involve an engineers judgement and experience with the manufacturing process and the likelihood of latent defects

INPUT REQUIREMENTS

Number of latent defects detected by thermal screening per 100 units.
Number of latent defects detected by random vibrations per 100 units.
Average repair cost to correct a defect at an assembly level.
Thermal cycling used (y/n)?
Powered thermal cycling used?
Thermal screen cost.
Number of thermal cycles.
Rate of change in thermal cycle.
Vibration screen used (y/n)?
Type of vibration.
Vibration screen cost.
Vibration cost.
Vibration time.
Force in G's.

AVAILABLE OUTPUTS

Total ESS efficiency.
Pre-DD250 cost.
Post-DD250 cost.
Total cost of ownership.

COMPUTER REQUIREMENTS

IBM-PC compatible (the code written in Fortran)
10 megabyte hard disk (minimum)
Math coprocessor

CURRENT FEATURES

This program is capable of up to a 5 level equipment breakdown structure. Level I corresponds to the first level of assemble, Level II to the next level, and etc. until the highest level corresponds to the "unit" level.

CURRENT LIMITATIONS

All programs assume a thorough understanding of ESS screens and a knowledge of potential areas of defects within the manufacturing process.

These programs are aids to determine the "optimum" ESS screen. They should not preclude common sense engineering or a survey prior to implementing ESS. Failure rates should also be verified after the implementation of the screens if ESS is initiated.

POINT OF CONTACT

At TACOM: Mr. Duane Smith, AMSTA-QHS AC (313) 574-5768 AV 786-5768
At U.S. Army Armament, Munitions and Chemical Command (AMCCOM); Mr. Yoobong Kim AC (309) 782-7136 AV 793-7135. Mr. Kim is one of the developers of this set of models.

AMCCOM ENVIRONMENTAL STRESS SCREENING COST MODEL-MODULE 2

DESCRIPTION

The AMCCOM Environmental Stress Screening Cost Model is composed of three modules, each of which model an aspect of the envorinmental stress screening problem.

Module 2 of AMCCOM Environmental Stress Screening Cost Model is Life Cycle Failures. This module estimates life cycle field failures with and without ESS.

INPUT REQUIREMENTS

Number of fielded units non ESS
- Mean time between failures
- Constant fielding rate

Number of spares fielded
- Mean time between failure
- Constant fielding rate

ESS units fielded
- Mean Time between failures
- Constant fielding rate

ESS spares
- Mean time between failures

All units:
- Operating time per year
- Number of years projected use

AVAILABLE OUTPUTS

Failure prediction without ESS
Failure prediction with ESS

COMPUTER REQUIREMENTS

IBM-PC compatible (the code written in Fortran)
10 megabyte hard disk (minimum)
Math coprocessor

CURRENT FEATURES

Estimates the number of failures that can be avoided in the life cycle of a system.

CURRENT LIMITATIONS

All programs assume a thorough understanding of ESS screens and a knowledge of potential areas of defects within the manufacturing process.

These programs are aids to determine the "optimum" ESS screen. They should not preclude common sense engineering or a survey prior to implementing ESS. Failure rates should also be verified after the implementation of the screens if ESS is initiated.

POINT OF CONTACT

At TACOM: Mr. Duane Smith, AMSTA-QHS AC (313) 574-5768 AV 786-5768
At U.S. Army Armament, Munitions and Chemical Command (AMCCOM);
Mr. Yoobong Kim AC (309) 782-7136 av 793-7135. Mr. Kim is one of the developers of this set of models.

AMCCOM ENVIRONMENTAL STRESS SCREENING COST MODEL-MODULE 3

DESCRIPTION

The AMCCOM Environmental Stress Screening Cost Model is composed of three modules, each of which model an aspect of the envorinmental stress screening problem.

Module 3 of AMCCOM Environmental Stress Screening Cost Model is Estimate Owners Cost. This module estimates the owners cost for a selected ESS plan.

INPUT REQUIREMENTS

- Labor rate
- ESS screen cost
- Thermal power cost
- Vibration power cost
- Production rate
- Units on contract
- Fixed in plant repair cost
- Fixed in plant allocation factor
- Return to vendor allocation factor
- Return to vendor repair cost
- Defects to field allocation factor
- Defects to field repair cost
- Existing number of thermal chambers
- Existing number of random vibrators
- Cost of random vibrators

AVAILABLE OUTPUTS

- Repair cost
- Defects detectable by thermal screen
- Defects detectable by vibration screen
- Thermal screen characteristics
- Vibration screen characteristics
- Cost of basic equipment
- Cost of monitoring equipment

COMPUTER REQUIREMENTS

IBM-PC compatible (the code written in Fortran)
10 megabyte hard disk (minimum)
Math coprocessor

CURRENT FEATURES

This program will be used by engineers to finalize ESS screens in conjunction with Mil-STD-217A

CURRENT LIMITATIONS

All programs assume a thorough understanding of ESS screens and a knowledge of potential areas of defects within the manufacturing process.

These programs are aids to determine the "optimum" ESS screen. They should not preclude common sense engineering or a survey prior to implementing ESS. Failure rates should also be verified after the implementation of the screens if ESS is initiated.

POINT OF CONTACT

At TACOM: Mr. Duane Smith, AMSTA-QHS AC (313) 574-5768 AV 786-5768
At U.S. Army Armament, Munitions and Chemical Command (AMCCOM);
Mr. Yoobong Kim AC (309) 782-7136 av 793-7135. Mr. Kim is one of the developers of this set of models.

FLEET MODERNIZATION AUTOMATED COST MODEL (FMACM)

DESCRIPTION

FMACM is a cost model which predicts the cost of various roles/vehicles considering the impact of commonality inherent in these vehicles. FMACM was developed to develop costs for the Armored Family of Vehicles

INPUT REQUIREMENTS

Unit cost by technology
Learning curve factors by Technology.
Role/vehicle production quantity.
Prototype quantity.
Multi-year production factors.
Role specific cost factors.
Sustainment cost variables:
- Crew.
- Labor rates.
- Training.
- MTBF, etc.

AVAILABLE OUTPUTS

Cost for each role/vehicle by DCA-P-92(R) cost cell for:
- Development.
- Production.
- Sustainment.

DCA-P-92(R) Matrices:
- -C
- -D1
- -D2
- -D3
- -G

Average Annual Sustainment Cost.

COMPUTER REQUIREMENTS

Operational on TACOM's PRIME computer. The model uses CPL, FORTRAN, S2020, and Info DBMS.

CURRENT FEATURES

Considers impact of commonality.
Multi-system Costing (up to 40).
Three Dimensional learning curves.
Weapons system costing for:
- Development.
- Production.
- Fielding and sustainment.

CURRENT LIMITATIONS

Cumulative computations (not yearly).

POINT OF CONTACT

U.S. Army Tank Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division, AMSTA-VC (Mr. Ron Hayostek). Warren, MI 48397-5000

AC (313) 574-8719 AUTOVON 786-8719

LOGISTICS ANALYSIS MODEL (LOGAM)

DESCRIPTION

LOGAM is a tool for the evaluation of alternative support postures for Army equipment. It is a deterministic model structured to perform logistics analyses in maintenance support situations where the emphasis is on the support channels required for a diversity of operating equipment. LOGAM can be used to evaluate alternate maintenance postures on the basis of Life Cycle Costs (LCC). Although operational and maintenance costs are emphasized, the model accounts for development and investment costs of prime and test equipment, spares, and facilities. In addition to LOGAM maintenance costs, LOGAM has the capability to evaluate theater Operation and Maintenance (O&M) costs from a Table of Organization and Equipment (TOE). TOE maintenance personnel costs can be evaluated from personnel data. Costs are printed at the theater level (case total) using both the LOGAM and DA PAM 11-4 format. LOGAM maintenance analysis is based on a four support system (i.e., organization, direct support, general support and depot). The test equipment and manpower demands are determined by the flow of materiel at a support echelon generated by the maintenance incident rate, mean time between maintenance actions, the "on" time fraction, scrap rate, false "no go" rate, and attrition. The maintenance demands and spares requirements at a support echelon are a result of the maintenance policy(s) used. LOGAM has 20 different maintenance policies to select from. The user can elect to choose any one of these policies or any combination of policies.

INPUT REQUIREMENTS

There are basically three types of input data: deployment, Line Replaceable Unit (LRU), and common. LRU inputs are those which are peculiar to each LRU such as physical characteristics and procurement cost. Common inputs are those which are common to all LRU's such as flags, shipping costs, and cost for test personnel. In addition to these basic input parameters, the user can add up to 200 input parameters from the Table of Organization and Equipment (TOE), such as ammunition usage, operating personnel costs, and personnel attrition rates.

AVAILABLE OUTPUTS

Outputs include initial provisioning outputs, individual LRU outputs, summarized LRU case outputs, case totals, grand totals, maintenance manpower outputs, system maintenance cost case totals, system Operation and Support (O&S) cost case totals, system maintenance grand total costs, sensitivity analysis outputs, and output of input values.

COMPUTER REQUIREMENTS

Language: Fortran IV 77
Hardware: CDC Cyber 74, PRIME 75 0/850, IBM 360, CDC 6500/6600

CURRENT FEATURES

Life Cycle Application: Concept, D&V, FSD, P/D
LSAR Interface (Data Records): A, B, C, D, E, F, G, H, J
LSA Task Interface: 203.2.3, 5-7; 204.2.1; 205.2.1; 302.2.1-3; 303.2.1-3, 7, 8; 401.2.3, 8

CURRENT LIMITATIONS

Non-standard Routines: Supply Allocation Availability calculations Modules and Parts Data Average

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Readiness Directorate, ILS Functions (AMSTA-KP), Dr. Joseph Brierly, Warren, Michigan 48397-5000

AC (313) 574-6909 AUTOVON 786-6909

BRITISH ARMY MAINTENANCE EXPENDITURE LIMIT (MEL) MODEL

DESCRIPTION

The MEL Model is used to develop an economic replacement policy for a vehicle fleet by minimizing the overall fleet operating costs. This is accomplished by using stochastic processes and dynamic programming techniques to develop an optimal maintenance policy for the fleet.

INPUT REQUIREMENTS

Major inputs are:
- Vehicle replacement cost
- Mean number of unscheduled maintenance incidents at vehicle year of life 1.
- Mean number of unscheduled maintenance incidents at vehicle year of life x*,
- Variance of number of unscheduled maintenance incidents at vehicle year of life 1.
- Variance of number of unscheduled maintenance incidents at vehicle year of life x*.
- Mean cost per unscheduled maintenance incident at vehicle year of life 1 and x*.
- Standard deviation of unscheduled maintenance incident cost at vehicle year of life 1 and x*.

* Generally x=10.

AVAILABLE OUTPUTS

Listing shows for each year of life:
- The Optimum MEL
  - % of fleet which would survive under that MEL.
  - Fleet distribution.
  - Expected number of maintenance actions per year.
  - Expected maintenance cost per year.

Also shows for this MEL policy:
- Expected length of life (with variance).
- Mean age of the fleet.
- Median age of the fleet.
- Partitioning of costs by:
  - New buys.
  - Repair labor costs.
  - Repair parts cost.

COMPUTER REQUIREMENTS

SIMSCRIPT and FORTRAN versions of the model operational on TACOM's PRIME. FORTRAN version also operational as executable file for personal computers. AMSAA has versions in other languages (ALGOL).

CURRENT FEATURES

Also can be used to:

Evaluate alternative MEL policies input by the user.

Evaluate various vehicle resale policies.

Evaluate costs of allocating vehicles in different age groups to various Active Army and Reserve rolls.

CURRENT LIMITATIONS

Input data:

Number of maintenance incidents, cost per maintenance incidents, and the variance and standard deviation of these values must not decrease with vehicle age.

Maintenance incident variance should not be more than 3 times the mean.

Assumptions:

Fleet size is constant.

Fleet age structure has settled down.

Policy will continue to operate and is rigidly enforced.

Vehicles are replaced by like vehicles.

Vehicles are immediately replaced after disposal,

POINT OF CONTACT

U.S Army Tank-Automotive Command, Systems and Cost Analysis Directorate, Systems Analysis Division (AMSTA-VS), Ms. Rozanski/Mr. Kerr, Warren, Michigan 48397-500

AC (313) 574-8699/8691 AUTOVON 786-8699/8691

MULTI-SYSTEM COST MODEL (MSCM)

DESCRIPTION

MSCM is currently under development. There is currently an operational Beta test version. It is to be a replacement for Fleet Modernization Automated Cost Model (FMACM) with expanded capability. As such, it will be a cost model which predicts the cost of various roles/vehicles considering the impact of commonality inherent in these vehicles. The model's inputs, outputs, and features are not fully known at this time. However, these characteristics should be similar to the FMACM characteristics listed below.

INPUT REQUIREMENTS

Unit cost by technology
Learning curve factors by Technology.
Role/vehicle production quantity.
Prototype quantity.
Multi-year production factors.
Role specific cost factors.
Sustainment cost variables:
- Crew.
- Labor rates.
- Training.
- MTBF, etc.

AVAILABLE OUTPUTS

Cost for each role/vehicle by DCA-P-92(R) cost cell for:
- Development.
- Production.
- Sustainment.

Average Annual Sustainment Cost.
Database to which the user can make needed reports.

COMPUTER REQUIREMENTS

MSCM is being developed on and for the Cost Analysis Division Sperry 5000/80 computer.

CURRENT FEATURES

Considers impact of commonality.
Multi-system Costing (up to 40).
Three Dimensional learning curves.
Weapons system costing for:
  Development.
  Production.
  Fielding and sustainment.

CURRENT LIMITATIONS

Unknown at this time.

POINT OF CONTACT

U.S. Army Tank Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division, AMSTA-VC (Mr. Ron Hayostek). Warren, MI 48397-5000

AC (313) 574-8719 AUTOVON 786-8719

OPERATIONAL BASELINE COST ESTIMATE (OBCE)

DESCRIPTION

OBCE is still in the development stage. It will assist cost analysts and program/project management personnel in developing cost estimates for weapon systems. It will also assist in the management of financial resources for these systems.

INPUT REQUIREMENTS

Cost Estimating Portion
- Program data:
  - Phase begin year
  - Phase end year, etc
- Model and Theater cost elements
- Work breakdown structure.
- Cost factors by appropriation.
- Equations for cost elements.
- Quantities matrix.
- Variables for equations.

Program Management Portion:
- Operating Program Information
- Work Breakdown information/operating plan/obligation.
- PRON linking information/funding data.
- Automated PRON data.
- Operating Program Index.

AVAILABLE OUTPUTS

Cost Estimating
- Matrices for "Big 5" reports.
- BCE cost data backup sheets including:
  - Variable explanation
  - Cost data sheets.
- BCE report readiness
- Print of all data entered.
- Print results for each cost element

Program management:
- Summary Program Status
- Program status (Planed and Actual)
- Program status by manager.
- Obligation status.
- PWD - PRON status by account
- Summary of Operating Plan:
  - Operating Plan.
  - Plan change - History:
    - by account.
    - by sequence.

COMPUTER REQUIREMENTS

Approved portion operational on Cost Analysis Division's Sperry 5000/80.

CURRENT FEATURES

Standardizes reporting of cost matrices throughout AMC
Built-in matrix calculator can use matrix data to calculate cost.

CURRENT LIMITATIONS

OBCE is currently in the development phase.
It cannot have current year and base cost year different.
It cannot save intermediate equations and results together.
Titles of subcosts elements cannot be changed.

POINT OF CONTACT

U.S. Army Tank Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division, AMSTA-VC (Ms. Susan Gunnell). Warren, MI 48397-5000

AC (313) 574-8703 AUTOVON 786-8703

OPTIMUM SUPPLY AND MAINTENANCE MODEL (OSAMM)

DESCRIPTION

OSAMM simultaneously optimizes supply and maintenance policies while achieving a given operational availability target. It determines at which echelon each maintenance function should be eliminated; i.e., it does repair versus discard analysis as part of Level of Repair Analysis (LORA). OSAMM incorporates the same supply algorithms as the SESAME model. These algorithms optimally allocate spares to achieve an operational availability goal at minimum cost. In making the repair level decision, the model considers the spares, test equipment, and repairmen that will be needed to support the maintenance policy. Other costs such as transportation, cataloging, and documentation are also considered. OSAMM considers three levels of indenture within an end item: components, modules, and piece parts. Failure rates are input by organizational, Direct Support Unit (DSU), General Support Unit (GSU), and depot.

INPUT REQUIREMENTS

Inputs include:
(1) end item data
(2) deployment information
(3) maintenance policies to be considered
(4) echelon parameters
(5) cost parameters
(6) test equipment data
(7) repairment data
(8) component data
(9) pseudo component data
(10) module data
(11) psuedo module data
(12) application data

AVAILABLE OUTPUTS

Outputs include:
(1) maintenance policies by application
(2) Maintenance Task Distributions (MTD's) and Replacement Task Distributions (RTD's)
(3) quantity required of each test equipment/repairman at each echelon
(4) number of spares at each component/module allowed at each echelon, initial spares cost, and consumption spares cost over the life of the system
(5) total cost of each component/module for holding, transportation, requisition, cataloging, bin and repair
(6) total logistics cost and achieved operational availability

COMPUTER REQUIREMENTS

Language: Fortran
Hardware: CDC Timeshare; IBM 4341

CURRENT FEATURES

Life Cycle Application: Concept, D&V, FSD, P/D
LSAR Interface (Data Records): A, B, C, D, E, F, G, H, J
LSA Task Interface: 203.2.3-5, 7; 204.2.1; 205.2.1, 5; 302.2.1-4; 303.2.1-4, 6-8; 501.2.5

CURRENT LIMITATIONS

Lack of Life Cycle Cost Coverage
Time-Sharing Cost

POINT OF CONTACT

U.S. Army Communications and Electronics Command, Directorate for Plans, Operations and Analysis, Systems Analysis Division (AMSEL-PL-SA), Dr. Charles Plumeri, Fort Monmouth, New Jersey 07703-5001

AC (201) 532-5170 AUTOVON 992-5170

SERVICE LIFE EXTENSION PROGRAM (SLEP) MODEL

DESCRIPTION

The SLEP model is an operation cost model which computes the total investment and maintenance costs for various maintenance/overhaul policies for a given number of years. Originally modeled as a dynamic program, the model has been simplified over the years. The model is capable of determining the optimal SLEP strategy and is capable of using mixed strategies.

INPUT REQUIREMENTS

Duration of study period.
Number of vehicles entering the SLEP fleet each year.
Equivalent age of the vehicles entering the SLEP fleet during any given year (Cohort Age).
Discount rate.
Inflation indicies.
Investment cost of the various policies.
Maintenance cost curves for the various policies. These can be linear or quadratic (failure per year and cost per failure).
Equivalent age after overhaul and transportation cost for vehicles.
Various maintenance parameters (set at time of run).
Army, Reserve, and Storage fleet breakdown.

AVAILABLE OUTPUTS

Total program cost, total maintenance cost, total investment cost.
Cost (Maintenance, investment, total) per year.
Policies pursued and detailed policy cost information.
Optimal mix of policies (optimal mode only).
Comparison of various (non-mixed) strategies (non-mixed mode only).
Residual life of vehicles and residual value (optimal).
Inflated, Discounted and Constant dollars.
Army, Reserve, and Storage fleet cost.

COMPUTER REQUIREMENTS

Operational on TACOM's Prime Computer. This model is written in Prime's Pascal language.

CURRENT FEATURES

Capable of handling two vehicle fleets (one at a time).
Up to seven maintenance policies may be handled at one time.
Discount, Inflated, and Constant Dollars may be computed.
Program recognizes "status quo" option.
Residual values may compute.
Reinvestment (re-SLEPing) may suppressed.
Variable length of runs.

CURRENT LIMITATIONS

All vehicles entering the system during a given year must be of the same age.
At most, seven maintenance policies may be considered at one time.
Dynamic Programming capability is not currently available.
Maximum duration of 25 years for the SLEP program.
Cost data files must be prepared manually (there is no preprocessor)

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division, (AMSTA-VS), Mr. Osman Gothamy, Warren, Michigan 48397-5000

AC (313) 574-6819 AUTOVON 786-6819

TECHNICAL DATA PACKAGE (TDP) COST TRADE-OFF ANALYSIS MODEL

DESCRIPTION

TDP Cost Trade-off Analysis is a cost model which calculated the savings that would result if a TDP is developed and performs a break even analysis for a TDP.

INPUT REQUIREMENTS

Base Year of analysis.
Number of years covered by the analysis.
First year of procurement.
Cost of the TDP development.
Unit cost of the item.
Additional nonrecurring cost.
Discount rate.
Competition savings factor.
Learning curve parameters.
Production schedule.
Composite inflation indices.

AVAILABLE OUTPUTS

Potential Competition savings cost.
TDP net potential savings.
Return on investment.

COMPUTER REQUIREMENTS

IBM PC/XT or AT (or compatible with 5.25 disk drive).

CURRENT FEATURES	CURRENT LIMITATIONS
Calculates the break even cost of the TDP as well as the cost savings.	Can only calculate savings for 10 years.

POINT OF CONTACT

U.S. Army Tank-Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division, (AMSTA-VC), Ms. Susan Gunnell, Warren, Michigan 48397-5000

AC (313) 574-8703 AUTOVON 786-8703

TACOM WHEELED AND TRACKED VEHICLE COST DATA BASE MODEL

DESCRIPTION

TACOM's Wheeled and Tracked Vehicle Cost Data Base Model is a collection of historical cost data (primarily contractual) which is linked together to assist in developing estimates for new vehicle systems, as well as providing a source of data on existing vehicle systems..

INPUT REQUIREMENTS

Cost data configured to the Army "Big 5" cost category structure.
Technical data on performance and specifications for new vehicles.

AVAILABLE OUTPUTS

Reports showing cost information for contracts (or pseudo contracts) associated with specific vehicles. Reports show cost by cost cell structure, work breakdown structure, appropriations and key cost terms (unit hardware, flyaway, etc.).
Technical data is also available via preprogrammed reports.
Ad hoc reporting via FOCUS DBMS query language allows considerable latitude in tailoring reports to requirements.

COMPUTER REQUIREMENTS

The system is currently operational on an NCR PC810 within the Cost Analysis Division of TACOM. The model, data base, PC-FOCUS, and preprogrammed coding uses approximately 10 MB of fixed disk storage.

CURRENT FEATURES

11 different canned reports.
Capability to generate tailored reports to suit individual requirements.
Statistical package included in DBMS for use in statistical analysis of data.

CURRENT LIMITATIONS

System operates slowly during report generation.
Gaps in data collected on many vehicle systems.
Virtually no operating and support costs available in the data base.

POINT OF CONTACT

U.S Army Tank-Automotive Command, Systems and Cost Analysis Directorate, Cost Analysis Division (AMSTA-VC), Mr. William White, Warren, Michigan 48397-5000

AC (313) 574-8695 AUTOVON 786-8695

WARRANTY COST ANALYSES MODEL (WARCAM)

DESCRIPTION

WARCAM was developed at TACOM as an improvement on the Warranty Analysis Model (WARM) developed by AVSCOM. WARCAM compares the cost of a warranty with the costs of the no-warranty options. The expected savings from purchasing the warranty is given.

INPUT REQUIREMENTS

Economic life of item
Delivery schedule:
  Items
  Spares
Excalation indices
Warranted Mean Usage Between Failure (MUBF)
MUBF range:
  Low MUBF
  High MUBF
  Median MUBF
  Step size (for ranging)
MUBF factors
Discount rate
Inherent Failure rate
Valid claim rate
GS-level repair rate
Repair costs for warranty option:
  Warranted failures
  Non warranted failures
Post warranty failures
Repair costs for no warranty
Warranty limits (time & usage)
Warranty type (failure free/threshold)
Failure threshold
Failure per item limit (0 - infinite)
Time units (years/months)
Distribution type for MUBF
  (Triangular/Weibull)

AVAILABLE OUTPUTS

Expected number of failures at warrantied MUBF
Break out of costs at warrantied MUBF
Distribution of failures at the warrantied MUBF
For each step through range of MUBF's:
  Cumulative probability of not exceeding that MUBF
  Expected number of warranted failures and of all failures.
  Cost estimates for the warranty and no warranty options.
Expected value of the warranty
Cumulative probabilities for:
  Costs under warranty
  Costs for no warranty options.

COMPUTER REQUIREMENTS

Written in FORTRAN 77. Operational on TACOM's PRIME computer.

CURRENT FEATURES

Failure free vs Threshold Warranties.
Finite vs Infinite Failures per item.
Calculates time when threshold is reached.
Sensitivity analysis on the warranted MUBF.

CURRENT LIMITATIONS

Item oriented - Costs and MUBF for systems must be computed manually after development of costs and MUBF for components interactive.

POINT OF CONTACT

U.S Army Tank-Automotive Command, Systems and Cost Analysis Directorate, Systems Analysis Division (AMSTA-VS), Mr. David Grant, Warren, Michigan 48397-500

AC (313) 574-8698 AUTOVON 786-8698

DISTRIBUTION LIST

	Copies
Commander Defense Technical Information Center Bldg. 5, Cameron Station ATTN: DDAC Alexandria, VA 22304-9990	12
Manager Defense Logistics Studies Information Exchange ATTN: AMXMC-D Fort Lee, VA 23801-6044	2
Commander U.S. Army Tank-Automotive Command ATTN: ASQNC-TAC-DIT (Technical Library) Bldg. 203 Warren, MI 48397-5000	2
Director U.S. Army Materiel Systems Analysis Activity ATTN: AMXSY-MP (Mr. Cohen) Aberdeen Proving Ground, MD 21005-5071	1
Commander U. S. Army Materiel Command ATTN: AMCDRA (Mr. R. O. Black) 5001 Eisenhower Avenue Alexandria, VA 22333-0001	1
Commander U.S. Army Armament Research, Development and Engineering Center ATTN: SMCAR-TD Headquarters, Armament Munitions and Chemical Command Picatinny Arsenal, NJ 07806-5000	1
Commander U.S. Army Aviation Systems Command ATTN: AMSAV-GTD (Mr. Charles C. Crawford, Jr.) Federal Center 4300 Goodfellow Blvd. St. Louis, MO 63120-1798	1
Commander U.S. Army Communications-Electronics Command ATTN: AMSEL-ATDD-RT Fort Monmouth, NJ 07703-5001	1

Commander 1
U.S. Army Depot System Command
ATTN: Technical Director
Chambersburg, PA 17201-4170

Commander 1
U.S. Army Laboratory Command
ATTN: AMSLC-TD
Adelphi, MD 20783-1145

Commander 1
U.S. Army Missile Command
ATTN: AMSMI-RD (Technical Director)
Redstone Arsenal, AL 35898-5000

Commander 1
U.S. Army Tank-Automotive Command
ATTN: AMSTA-CF (Dr. K. J. Oscar)
Warren, MI 48397-5000

Commander 50
U.S. Army Tank-Automotive Command
ATTN: AMSTA-RY (Dr. R. R. Beck)
Warren, MI 48397-5000

Commander 1
U.S. Army Test and Evaluation Command
ATTN: AMSTE-TD
Aberdeen Proving Ground, MD 21005-5055

Commander 1
U.S. Army Belvoir Research, Development and Engineering Center
ATTN: STRBE-ZT
Fort Belvoir, VA 22060-5606

Director 1
Ballistic Research Laboratory
ATTN: Technical Director
Aberdeen Proving Ground, MD 21005-65066

Commander and Director 1
Corps of Engineers
Waterways Experimental Station
ATTN: Technical Director
P.O. Box 631
Vicksburg, MS 39181-0631